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Characterising the Knowledge Approach of a Firm: An Investigation of Knowledge Activities in Five Software SMEs

Ciara Heavin and Frederic Adam

Business Information Systems, University College Cork, Ireland

c.heavin@ucc.ie

fadam@afis.ucc.ie

Abstract: An organisation's ability to successfully compete in a changing market place is contingent on its ability to manage what it knows, in order to serve the objectives of the firm. While it has been argued that due to their size, knowledge management (KM) is not a concern for smaller organisations, in the current economic climate, it is expected that a more formalised approach to KM allows the company to seize opportunities as they arise, and deal with environmental uncertainty more effectively. In view of this, the objective of this study was to devise a classification of knowledge activities (KAs) which facilitates the exploration of a Small to Medium Sized Enterprises (SMEs) in terms of the type and extent to which knowledge is managed. Furthermore, analysis of KAs provided a greater understanding of the fit between the firm's objectives and the KM approach pursued. In order to achieve this, five case studies were conducted. Based on the classification of KAs identified, a qualitative analysis approach was used to code each of the twenty eight interviews carried out. Both quantitative and qualitative content analysis methods were applied to facilitate data reduction and generate meaning from the significant volume of data collected. The output from this study includes a classification of KAs which provides rich insight into how SMEs are motivated to deal with knowledge as a means of achieving their organisational objectives. From a practitioner viewpoint, this study seeks to offer an improved understanding of a software SMEs' approach to KM.

Keywords: Knowledge Management (KM), Knowledge Activity (KA), knowledge, Small to Medium Sized Software Enterprises (SMES) and software

1. Introduction

While firms understand that managing what they know is important to their success, operationalising such an approach is a more difficult endeavour. This difficulty is attributed to the complex nature of the area where visibly observing, understanding, and measuring an organisation's approach to managing knowledge remains an arduous endeavour. Edwards (2005, p123) maintains that *"evaluation is a crucial topic for both the research and practice of knowledge management, and one that generates much controversy."* Recently, Delen and Al-Hawamdeh (2009, p141) argue that with *"the massive amounts of information being added to corporate databases and the Internet every day, effective and efficient knowledge discovery has become an imminent problem"*. It seems that with more sophisticated technology and the heightened availability of knowledge, KM has become a more pressing issue for those organisations who have not achieved this level of routinisation presented in extant research (Leavitt and Whisler, 1958; Huber, 1984). Moreover, Leavitt and Whisler's (1958, p41) postulations applied to *"the medium and large business firms of the future"* consequently overlooking the strategic future of smaller organisations. As the number of SMEs continue to grow through these challenging economic times, where entrepreneurship is increasingly encouraged and where small organisations provide the backbone to many western economies (European Commission, 2007; MacGregor and Bunker, 2000), the importance of understanding how smaller organisations manage what they know has become imperative to their survival. SMEs by their very nature differ from multinational enterprises (MNEs) (Penrose, 1959; Welsh and White, 1981); thus an SME's KM approach differs to that implemented by larger organisations. From an academic perspective further research in KM and SMEs is imperative, Tan *et al.* (2009) contend that while testing existing theories in a small firm context has advanced the nature of research in the area, greater attention needs to be attributed to theory building in technology, innovation and corporate social responsibility in small business research.

In examining the KM related literature, it may be observed that much of the current literature reflects the discourse proliferated by strategies and technologies implemented in larger organisations. This study seeks to overcome this problem by pursuing a study of KM in SMEs.

2. Defining knowledge

The concept of a continuum in IS is widely considered (Davis and Wetherbe, 1979; Mason and Mitroff, 1973; Davenport and Prusak, 1998; Wurman, 2001). A continuum is defined as a “*continuous sequence in which adjacent elements are not perceptibly different from each other, but the extremes are quite distinct.*” (Compact Oxford English Dictionary, 2005). Defining data, information and knowledge as distinct and independent phenomena is an arduous endeavour. In particular it is noted that many authors use the terms information and knowledge interchangeably, those (Dennis, Earl, El Sawy, Huber) that considered organisational information processing in the 1970s, 1980s and early 1990s now focus their attentions on KM as an organisational strategy. In essence information processing/management has become, at least in part, knowledge management. Figure 1 represents data, information and knowledge as a continuum.

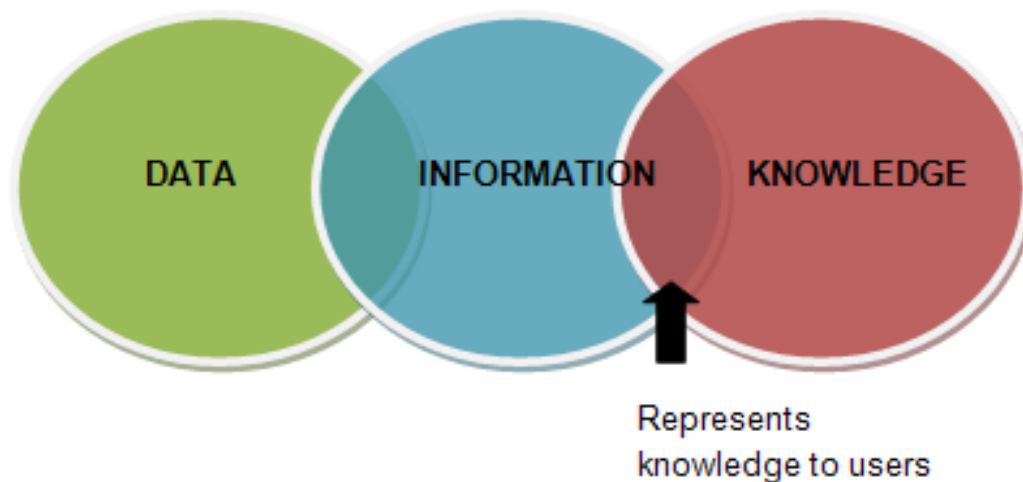


Figure 1: Knowledge continuum (after Davenport and Prusak, 1998; Wurman, 2001)

Figure 1 illustrates that the extremes of each phenomenon are distinct however there is significant overlap between data/information and information/knowledge. According to Davenport and Prusak (1998, p147) “*the distinction between knowledge and information is seen as more of a continuum than a sharp dichotomy. Most projects that focus on internal knowledge [repository] deal with the middle of the continuum-information that represents knowledge to certain users*”. The point where information becomes knowledge and vice versa is difficult to pinpoint with complete accuracy, however there is no doubt that these phenomena are closely linked. For the purpose of this study, it is at this point (illustrated in Figure 1) in the continuum where the knowledge focus of this study lies in order to identify and explore the nature of knowledge within the context of an SME.

3. Establishing a classification of KAs

While data and information are defined in static terms, knowledge is defined as having characteristics of movement (Barthelme *et al.*, 1998); “*information in action*” (O’Dell and Grayson, 1998, p.5). According to Davenport and Prusak (1998, p6) “*one of the reasons that we find knowledge valuable is that it is close-and closer than data or information- to action*”. From their perspective, “*we can use it to make wiser decisions about strategy, competitors, customers, distribution channels, and product and service life cycles*” (Davenport and Prusak, 1998, p6).

Like many areas of KM, the consideration of actions or activities that result in managing organisational knowledge is well contested amongst researchers. Considering knowledge sharing in the field of Artificial Intelligence, Gruber (1995) advocates the importance of developing ontologies to simplify and abstract a view of the domain under consideration. Holsapple and Joshi (2004) support this view, they acknowledge the need to develop a common language to facilitate the sharing and reuse of knowledge about a domain in order to enable advances in that area of research and, according to Beesley and Cooper (2008), in the business community as a whole. Holsapple and Joshi (2004, p91) refer to knowledge management episode (KME) as “*a pattern of activities performed by multiple processors with the objective of meeting some knowledge need*”. It is those activities that result in a KME which Holsapple and Joshi (2004) term knowledge manipulation activity or knowledge activity. For the purpose of this research, a definition of knowledge activity (KA) proposed by

Kraaijenbrink *et al.*, (2006, p23) is adopted as “*transactions or manipulations of knowledge where the knowledge is the object not the result*”. It is evident that multiple researchers use different terms for the same/similar activity. This research summarises the terms widely used to describe knowledge activities. These are presented in Table 1, the definitions listed share common verbs such as storing, creating and applying in an organisational context. This research takes a balanced view KAs, discounting the activities proposed by Leonard-Barton (1995) in Table 1, as they have a sole technical focus.

Table 1: The terms widely used to describe knowledge activities

Knowledge Management Activities	Author
Acquisition, Indexing, Filtering, Linking, Distributing Application	Alavi (1997)
Share, Creation, Identification, Collection, Adaptation, Organisation and Application	Arthur Anderson and APQC (1996)
Acquisition, Creation, Retention, Deployment and Leverage	Ceccez-Kecmanovic (2000)
Sensemaking, Knowledge Creation, Decision Making	Choo (1996)
Procurement, Organisation, Storage, Maintenance, Analysis, Creation, Presentation, Distribution, Application	Holsapple and Whinston (1987)
Acquisition, Storage, Dissemination	Huber (1990)
Elicitation, Codification, Detection, Assessment, Transfer of knowledge, Transfer of knowledge holder, Nurturing, Motivation	Kraaijenbrink <i>et al.</i> (2006)
Shared and creative problem solving, Importing and absorbing technological knowledge from external sources, Experimenting prototyping, Implementing and integrating new methodologies and tools	Leonard-Barton (1995)
Socialise, Internalise, Combine, Externalise	Nonaka (1991)
Construction, organisation, storage, distribution and application	Pentland (1995)
Initiation, Implementation, Ramp-up, Integration	Szulanski (1996)
Develop, Distribute, Combine, Hold	Van Der Spek and Spijkervet (1997)
Acquiring, Selecting, Internalising, Using, Externalising, Generating	Holsapple and Joshi (2004)
Creation, Manifestation, Use, Transfer	Wiig (1993)

In addition, Nonaka’s (1991) KAs are directly related to knowledge creation and are integrated into a single creation activity. After careful analysis, a refined set of six KAs are presented in Table 2. These encompass the key activities that occur when organisations endeavour to manage what they know.

Holsapple and Joshi (2004) state that there is a need for a common ontology that describes knowledge activities clearly and completely. They also advocate the importance of addressing the potential relationship between the activities (Holsapple and Joshi, 2004). The following section deals with each of the knowledge activities presented in Table 2. above using extant literature to cluster the core activities, as well as identifying the links between the KA.

Table 2: An Organisation's KAs

Knowledge Activity (KA)	Definition
Acquire	Identify and capture knowledge from source to a company. Sources include written form, physical objects, people, courses, cooperation between source and recipient, and outsourcing
Codify	Assess the value of knowledge, distil, refine and assemble into comprehensive format
Store	Store knowledge in an artefact e.g. system, document
Maintain	Update on continuous basis, as a result of additional acquisition activities
Transfer	Identify receiver, organize channel of communication and send
Create	New knowledge cultivated through knowledge transfer. Acquisition activities come into play as new knowledge is acquired

3.1 Acquire

From Huber's (1991, p90) perspective "*Knowledge acquisition is the process by which knowledge is obtained*". Kraaijenbrink *et al.* (2006) define knowledge acquisition as knowledge transferred from a source to a company through sub processes: written form, physical objects, people; cooperation between source and recipient; courses; and outsourcing.

3.2 Codify

Knowledge codification converts the generated knowledge into accessible and applicable formats (Davenport and Prusak, 1998). Combine, internalise or absorb are verbs that may be used to describe this activity. Knowledge codification is concerned with the capture, representation and storage of knowledge in computerised knowledge bases (Nevo *et al.*, 2007). Hansen *et al.*'s (1999) codification strategy supports the use of knowledge repositories e.g. documentation and more specifically technology i.e. databases to store organisational knowledge.

3.3 Store

According to Alavi and Leidner (2001, p127) knowledge storage *“involves obtaining the knowledge from organisational members and/or external sources, coding and indexing the knowledge (for later retrieval) and capturing it”*. The key to storing organizational knowledge is that the members must be able to anticipate the future needs of the organisation in order for the most valuable knowledge to be stored (Huber, 1991).

3.4 Maintain

The maintenance of knowledge stores is essential to the continued progression of an organisation's ability to learn. Holsapple and Singh (2004) refer to knowledge control to describe the provision of quantity and quality knowledge as a significant KA. They advocate that knowledge should be accurate, consistent (have validity), relevant and important (have utility). Accordingly, Anderson Consulting (1996) acknowledged the need for control over their knowledge repository to ensure useful, fresh and high quality knowledge, *“it would have be more than a dumping ground of documents”* (Holsapple and Singh, 2004, p239).

3.5 Transfer

Knowledge transfer is established through person-to-person or system-to-person interaction (Joe and Yoong, 2004). This supports Hansen *et al.*'s (1999) personalization strategy. From Table 1, it is evident that knowledge transfer occurs inside and outside the organisation. Thus, an organisation may transfer knowledge or receive it from outside the organisation, which is knowledge acquisition.

3.6 Create

Table 1 shows that knowledge creation involves developing new content or replacing existing content within the organization's tacit and explicit knowledge (Pentland, 1995). While it may be argued that new knowledge may be created through formalized mechanisms e.g. surveys and research and development (Kayworth and Leidner, 2004) others propose that the creation of new knowledge should not be a formalised process but one which is socially constructed and occurs over time through human networks (Brown and Duguid, 2000; Fahey and Prusak, 1998).

4. Research approach

The complex nature of KM coupled with the multifaceted characteristics of small software firms demanded an approach that facilitated the identification and exploration of these phenomena. The researcher pursued the strategy of purposeful sampling as a means of selecting information rich cases for this study (Miles and Huberman, 1994; Patton, 1990); the nature of innovative software products developed by these firms meant that this case displayed a wealth of KAs from the outset. As the objective of this study was to explore the KAs of small software firms, the focus of the study was on the two core business processes of sales and software development. Based on Knoke's (1994) selection strategy, the positional method was utilised to uncover those key players in the case study. The sales and software development managers were identified; other respondents were selected based on their reputations. In some cases the key technical roles were heavily involved in the sales function and were able to provide an in-depth insight into sales processes at the organisation. Twenty eight respondents in total were interviewed for this study.

The *“thick transcripts”* (Miles and Huberman, 1994) derived from the interview process coupled with the complexity of KM as an area of research provided the rationale for pursuing qualitative analysis through the use of coding techniques (Ägerfalk and Fitzgerald, 2008). The research approach pursued is synthesised in Figure 2.

For the purpose of this study six *“seed categories”* (Miles and Huberman, 1994) were proposed, these categories were initially derived from the literature. The many classifications of KAs have been assessed and evaluated to develop a complete classification of KAs for the purpose of data analysis in this study. Each KA was assigned a code and this code was utilised to classify the nature of KAs that occur, these categories were then assigned chunks of data derived from the interview transcripts. This iterative process derived a set of categories which capture the occurrences of KAs in the organisation as informed by the interviews. The KAs for each of the firms were collated based on each individual memo generated at the level of the interview. A counting analysis technique was used

to derive meaning from the large volume of data gathered. Miles and Huberman (1994) advocate the use of counting in qualitative analysis *"to rapidly see what you have in large batches of data"* (p253). The knowledge types were counted, the KAs were counted and the distribution across the six KAs was calculated for each case. The counts were derived from a populated table of KAs for each case (not included); aliases are used to protect the privacy of the companies under consideration.

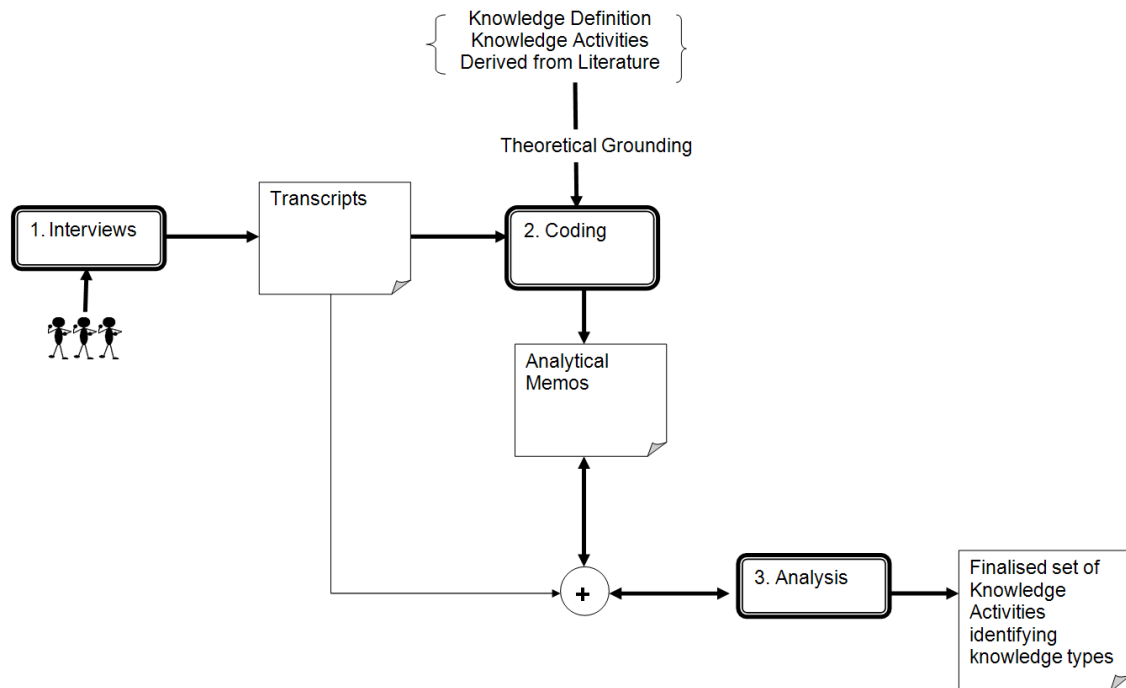


Figure 2: Schematic overview of analysis process (adapted from Ågerfalk and Fitzgerald, 2008)

5. Findings

This study pursued a replication logic across the five cases. An overview of each organisation is presented for in Table 3.

Table 3: Case background

<i>Company</i>	<i>Overview</i>
Case 1: HelpRead Ltd.	Produces assistive software to support learning disabilities. The complexity of the software product offering means that a deep understanding of customer requirements is essential to build a useful product. The complex customer requirements coupled with innovative management initiatives, such as brainstorming, provided rich insights from a KM perspective.
Case 2: TravelSoft Ltd.	Produced travel software to one main customer, who was also the company's main shareholder. In 2004, TravelSoft Ltd. took greater financial control of the organisation; while continuing to provide software to their former parent organisation. Change processes such as hiring new managers, pursuing product development and attracting 'third party customer' offered significant opportunities to study KM.
Case 3: Software Solutions Ltd.	Develops software solutions in the client server market. While significant knowledge activity was required to support the divisions independently, as well as the transfer activity across divisions, much knowledge activity was informal and ad-hoc in nature, primarily driven by focused sales activity.
Case 4: FinSoft Ltd.	A Dublin based firm focused on developing investment fund management software. This strategic focus meant that formally managing knowledge did not featured high on the FinSoft agenda; however the limited KM focus was primarily based on the need to meet compliance regulations in the financial investment sector.
Case 5: DocMan Ltd.	A small satellite operation for an edocument management software developer based in Givisiez, Switzerland. From a KM perspective, the size, location and functional specialization of the site presented unique characteristics for consideration.

5.1 Knowledge Activity at HelpRead Ltd

Table 4 identifies 82 instance of KA at HelpRead; the majority of activities presented themselves through knowledge acquisition, storage and transfer.

Table 4 identifies the distribution of KAs and the type of knowledge focus for each of these activities - these statistics are derived from the individual tables of KAs. The study identified 82 KAs; however we uncovered 113 instances of knowledge types. The difference in these figures can be explained by single KAs leveraging multiple knowledge types in some instances, thus increasing the instances of knowledge types identified in the analytic memos. It is also important to note that, at the time, HelpRead Ltd. was not in a new product development phase - at a time of new product development, higher number of KAs would be anticipated.

Table 4: Distribution of KAs at HelpRead Ltd.

KA /Company		HelpRead Ltd.	Percentage	Knowledge Focus by Activity
73%	Acquire	17	21%	53% Product Knowledge (9 of n=17 activities)
	Codify	11	13%	90% SW Dev, Project and Product Knowledge (10 of n=11 activities)
	Store	24	29%	71% SW Dev, Product, Project Knowledge (17 of n=24 activities)
	Maintain	8	10%	63% Project and SW Dev Knowledge (5 of n=8 activities)
27%	Transfer	17	21%	83% Product, Project and SW Dev Knowledge (14 of n=17 activities)
	Create	5	6%	80% Product Knowledge (4 of n=5 activities)
	Total	82	100%	

Using Table 4 the difference in intensity between these types of activities was indicative of HelpRead's position as a growing organisation. Knowledge acquisition intensity at 21 percent (n=82) showed that HelpRead were focused on building a collective organisational memory that facilitates continued growth through the introduction of new hires and new products. This was particularly important to them in terms of acquiring external knowledge to inform new product development. Fifty three percent of all knowledge acquisition activity was focused on gathering product knowledge supporting Groen's (2006, p124) view that in high-technology SMEs *"intensive interaction is needed to enhance the product creation process with knowledge from external sources"*.

At 13 percent (n=82) codification activity was relatively low intensity - this was reflective of the uncertainty around what the company needs to know in the future. This is predominantly evident with the Technical FAQ, which lacked buy-in from the entire development team. The Development Manager admitted that as a team *"they didn't know what they should know"*. Most codification activity was directly related to refining the discussions at group meetings into documents which are made available over the Intranet. Over 90 percent (n=11) of all codification activity identified in Table 4 was related to product development knowledge. Codification was largely not a sales related activity. The well defined scope of the *Goldmine™* sales system meant that no KA was required to support the refinement and distillation of sales related knowledge. In addition, the experience of the sales team meant they knew what important customer and sales related knowledge should be stored for future use.

The high occurrence of storage activities at 29 percent was indicative of the importance placed on storing knowledge in the new Intranet-based quality system - approx 74 percent (17 of n=24 storage activities) of storage activity involved the Intranet. These activities primarily included storing software project documents and employee skills documents, in line with the compliance requirements outlined by IS9001:2000. The codification intensity also included the level of customer information captured and stored by the sales team. This 29 percent reflected the move to store the knowledge gathered

from acquisition, codification and transfer activities. Hoch *et al.* (1998) purport that software companies with well established structure and processes reduce low level software rework and facilitates software reuse, it appears that HelpRead were moving in this direction. While the company were not focused on very sophisticated process certification, i.e. CMM, leveraging KM approaches offer an effective alternative (Baskerville and Pries-Heje, 1999).

Maintenance activities at 10 percent highlighted the company's focus on maintaining software and product development knowledge. Surprisingly, transfer activity was high intensity at 19 percent - with closer inspection; the role of the Technical Director was integral to this. At 6 percent, knowledge creation was very low. While Table 4 shows that 80 percent of knowledge creation activity was focused on product knowledge, in line with company strategy, the lack of other types of knowledge creation may be attributed to the pressures associated with the rapid growth in employee headcount and the increased product portfolio.

5.2 Knowledge Activity at TravelSoft Ltd

Table 5 shows that 147 instances of KAs were identified at TravelSoft Ltd.

Table 5: Distribution of KAs at TravelSoft Ltd.

KA/Company	TravelSoft Ltd.	Percentage	Knowledge Focus by Activity
66%	Acquire	16	11%
			44% SW Dev Knowledge (7 of n=16 activities) 25% Travel Industry knowledge (4 of n=16 activities)
	Codify	30	20%
			36% SW Dev (11 of n=31 activities) 32% Process/Product Knowledge (10 of n=31 activities)
	Store	31	21%
			41% SW Dev and Project Knowledge (12 of n=29 activities) 41% Process/Product Knowledge (12 of n=29 activities)
	Maintain	20	14%
			40% SW Dev and Project Knowledge (8 of n=20 activities) 40% Process/Product Knowledge (8 of n=20 activities)
34%	Transfer	41	28%
			68% SW Dev and Project Knowledge (28 of n=41 activities)
	Create	9	6%
			56% Product Knowledge (5 of n=9 activities)
	Total	147	100

The KAs in Table 5 leveraged more than one type of knowledge during a single activity, thus providing the rationale for the 211 instances of knowledge types identified for TravelSoft. The knowledge focus at TravelSoft was quite consistent and reflected the company's strategic objectives. The emphasis on software development, project, process and product knowledge was clear. Knowledge of the travel industry made up a quarter of the knowledge acquisition activity.

At HelpRead Ltd. 82 instances of KAs were observed, KA at TravelSoft was considerably higher at 147 instances. This intensity may be explained by a number of factors. At the time of interview a new Application Solutions Manager had been in place for approximately eight months. From a Telecoms background, he implemented a number of organisational strategies to develop embedded processes and most importantly to bring a new product to the travel software marketplace. It is primarily these management initiatives that contributed to the high density of KAs.

Table 5 shows knowledge acquisition activity at 11 percent (16 of n=147), this was due to the acquisition of consultant knowledge on new product development, employee training, relevant books,

journals and travel conferences. In terms of codification at 20 percent activity, project related knowledge was refined and stored. At 21 percent activity, storage activity was almost in line with the volume of codification activity. This indicates that TravelSoft were good at following through on this type of activity. For example the steering committee refine and store the new *Adept* framework templates in the relevant artefacts. R&D acquisition, codification, storage and maintenance of knowledge contribute to the dense volumes of KA. Activities such as Internet research in the travel area added to the level of knowledge acquisition activities, while refining and storing this knowledge contributed to the volume of codification and storage activity. At 14 percent, maintenance activity was lower than knowledge codification and storage activity. This could have been due to the fact that some of the knowledge stored does not require updating, for example conference and journal papers on the travel industry will not be changed although new papers may be added over time resulting in increased storage activity.

Knowledge transfer at 28 percent (41 where n=147) represented the highest volume of KA. Leveraging a variety of routine and non-routine modes (these are outlined in next section). This organisation encouraged knowledge transfer at all levels of the organisation. Knowledge creation is considerably lower at 9 instances (6 percent where n=147). These activities were all generated around new product and process development placing these initiatives at the core of all KAs of TravelSoft at that time. Table 5 shows a spread of 66 percent of KA at TravelSoft across knowledge acquisition, codification, storage and maintenance activity, while transfer and creation activity account for 34 percent of all KA. By comparison, the distribution at HelpRead for the same activities was 73 percent and 27 percent respectively. This shows that through their change process, TravelSoft were good at leveraging the more valuable types of KA.

5.3 Knowledge Activity at Systems Solutions Ltd

Table 6 illustrates a total of 105 KAs identified at Systems Solutions.

Table 6: Distribution of KAs at Systems Solutions

KA/Company	Systems Solutions	Percentage	Knowledge Focus by Activity
66%	Acquire	16	15%
			44% Product Knowledge (7 of n=16 activities) 31% Customer Knowledge (5 of n=16 activities)
	Codify	14	13%
			86% Sw Dev and Project Knowledge (12 of n=14 activities)
34%	Store	27	26%
			67% Sw Dev and Project Knowledge (18 of n=27)
	Maintain	13	12%
			38 % Sales Knowledge (5 of n=13 activities) 23% Project Knowledge (3 of n=13 activities)
	Transfer	30	29%
			60 % Sw Dev and Project Knowledge (18 of n=30 activities)
	Create	5	5%
			80 % Project Knowledge (4 of n=5 activities)
Total	105	100%	

We identified 131 instances of knowledge type across the KAs; this indicates that some KAs leveraged multiple knowledge types. From examining Table 6, it is apparent that knowledge acquisition and maintenance were exceptions in terms of their knowledge focus. Knowledge acquisition was focused on product and customer knowledge, these knowledge types were largely pertinent to the Business Service Management and SAP Solutions divisions focused on software resale. Knowledge maintenance activity was focused on sales knowledge at 38 percent of knowledge focus for that activity. The emphasis on sales primarily reflects the knowledge requirements of these two divisions. From Table 6, the other KAs were focused on software development and project

knowledge serving the knowledge needs of the Business Intelligence (data warehousing) and Application Development divisions.

At 105 instances, KA was mostly characterised by its informal nature. The Managing Director admitted that when he is involved with requirements analysis for the business intelligence division the knowledge is documented and stored in an A4 pad. In addition, one Project Manager from the Application Division admitted that it was not uncommon to calculate a project price on the back of a piece of paper in the car park before attending a meeting with a prospective customer.

Project related knowledge was codified, stored and maintained in order to meet the requirements of pharmaceutical customers who must abide by Food and Drugs Authority (FDA) regulations. From Table 6, it is evident that at 26 percent, storage activity was higher than both codification and maintenance activity together at 21 percent. This may mean that Systems Solutions store large volumes of documentation without refining and formatting it, and in the longer term, without updating it. As a result, it seems they hold large these volumes for the sole purpose of protecting themselves from external threats such as possible audits. At 15 percent, knowledge acquisition appeared important, however more than half of this activity is attributed to sales and customer interaction.

At 5 percent, knowledge creation activity was very low. The Managing Director was the main source of the knowledge creation activity at Systems Solutions. It seems that the time pressures associated with meeting project deadlines means that there was little time for knowledge creation activity amongst the divisions. In the case of Systems Solutions knowledge creation was not the responsibility of those at an operational level.

Knowledge acquisition, codification, storage and maintenance account for 66 percent of all KAs while knowledge transfer and creation amount to 34 percent. This is consistent with TravelSoft however, it differs in the case of HelpRead whose focus on knowledge storage activity through the new company Intranet tips the balance of KA distribution towards the earlier activities.

5.4 Knowledge Activity at FinSoft Ltd

Table 7 illustrates 78 instances of KAs identified at FinSoft Ltd..

Table 7: Distribution of KAs at FinSoft Ltd.

	KA /Company	FinSoft Ltd.	Percentage	Knowledge Focus by Activity
67%	Acquire	9	11%	67% Customer Knowledge (6 of n=9 activities)
	Codify	13	17%	92% Sw Dev and Project Knowledge (12 of n=13 activities)
	Store	20	26%	70% Sw Dev and Project Knowledge (14 of n=20 activities)
	Maintain	10	13%	50% Sw Dev and Project (5 of n=10 activities) 30% Customer Knowledge (3 of n=10 activities)
33%	Transfer	23	29%	78% Sw Dev and Project Knowledge (18 of n=23 activities)
	Create	3	4%	67% Product Knowledge (2 of n=3 activities)
	Total	78	100%	

We identified 111 instances of knowledge types across the KAs; this indicates that KAs at FinSoft Ltd. leveraged more than one type of knowledge during KAs. Table 7 shows a consistent knowledge focus on software development and project knowledge across knowledge codification, storage, maintenance and transfer activity. Knowledge acquisition activity focused on customer knowledge, while creation activity leveraged product knowledge.

Knowledge acquisition activity is primarily related to the sales and customer knowledge at FinSoft Ltd.. While 11 percent (9 where n=78) of KA was external knowledge acquisition, a large portion of

this activity was impromptu in nature although it was driven by the Head of Sales and the Chief Technology Officer (CTO). Knowledge codification, storage and maintenance activity at 46 percent (43 where n=78) was primarily related to project knowledge and software development activity. However as FinSoft Ltd. is a supplier of investment fund data feeds and bespoke fund management software, this activity was conducted to protect the organisation from issues arising from regular internal audits.

Knowledge transfer at 29 percent (23 where n=78) intensity occurred amongst the teams, software developers, quality assurance (QA), data, sales and senior management. While it was admitted that knowledge transfer between the software development team and Quality Assurance was effective, the Head of the Data team disclosed that knowledge transfer amongst the other division needed improvement. Knowledge creation activity was extremely low at 3 instances (4 percent where n=78), management are typically involved in these activities focused around attracting new customers and creating potential new product ideas. However, they did not seem to expend significant resources in creating new ideas in-house.

At FinSoft Ltd. the distribution of acquire, codify, store and maintain activities to knowledge transfer and creation activities were at 66 percent and 34 percent respectively. While at HelpRead this distribution was at 74 percent and 26 percent, however the focus there was on the development of the Intranet and collaborative wiki technologies, with knowledge storage activity accounting for a significant proportion of the 74 percent (29 percent storage activity).

5.5 Knowledge Activity at DocMan (Ireland) Ltd

The breakdown of KAs for DocMan (Ireland) Ltd. is presented in Table 8.

Table 8: Distribution of KAs at DocMan (Ireland) Ltd.

KA/Company	DocMan Ltd.	Percentage	Knowledge Focus by Activity
57%	Acquire	7	12%
			57% SW Dev Knowledge (4 of n=7 activities) 43% Customer Knowledge (3 of n=7 activities)
	Codify	11	18%
			64% SW Dev and Project Knowledge (7 of n=11 activities)
43%	Store	9	15%
			67% SW Dev and Project Knowledge (6 of n=9 activities)
	Maintain	7	12%
			57% SW Dev and Project Knowledge (4 of n=7 activities)
43%	Transfer	24	40%
			79% SW Dev and Project Knowledge (19 of n=24 activities)
	Create	2	3%
			100% SW Dev and Project Knowledge (2 of n=2 activities)
Total	60	100%	

From Table 8 at 60 activities, the total volume of KA was low in comparison to the other cases considered in this study. This may be attributed to the nature of the well defined work on software development components at the DocMan site in Ireland. The operations at the Irish site are part of a larger document management software component and the output from DocMan (Ireland) is integrated by the software integrator at the Swiss headquarters. As a result of this task specificity, there appeared to be a set of core KAs from which there was minimal diversification at the Irish site. Table 8 illustrates a significant level of knowledge consistency across all of the KAs. Software development and project knowledge represented at least 57 percent of the knowledge focus for all six KAs. This uniformity across activities also supports the task specialisation activity at the DocMan (Ireland) site.

Table 8 indicates that DocMan (Ireland) leveraged some external knowledge resources at 12 percent (7 where n=60) knowledge acquisition, however the main source of knowledge is the headquarters in Switzerland and this was achieved through knowledge transfer activity which is very high at 40

percent (24 where n=60) of total activity. It is from here that the majority of customer requirements are received as well as any new product knowledge.

In addition, knowledge creation activity was very low at 3 percent (2 where n=60). This may be the result of the location of this development team with most new ideas being generated at a higher level at company headquarters.

Although the total volume of KA was low, the split between the acquire, codify, store and maintain KA at 57 percent and the knowledge transfer and creation activity at 43 percent is more evenly balanced than that observed at HelpRead Ltd., at 73 percent and 27 percent respectively. The geographic location, the task specialisation and the maturity of the parent organisation may be attributed to the knowledge transfer capabilities identified at DocMan Ireland.

6. Discussion

Table 9 synthesizes KAs across the five cases. The highest and the lowest occurrences of KA for each company are coloured green and red respectively. The real number and the percentage of KA instances are presented along with the total KA and percentage of KAs.

Table 9 identifies the difference in the number of occurrences of KAs in each company. TravelSoft represents 31 percent (147 where n=472) of all KAs identified. At the time of this study, TravelSoft was very focused on establishing and implementing a project management framework for all new projects as well as an innovation management process for new product development. As a result, it may be that TravelSoft was experiencing exceptionally high levels of KAs at that time. In sharp contrast, DocMan provided the lowest number of instances of KAs with 13 percent (60 where n=472) of all occurrences. While one could attribute this to the number of respondents interviewed for the study (4), it is more likely that this low density of KAs may be explained by the very well defined nature of the work carried out at this small company.

Table 9: KAs in five Software SMEs

KA /Company	Systems Solutions	HelpRead Ltd.	TravelSoft Ltd.	FinSoft Ltd.	DocMan Ireland	Total
Acquire	16(15%)	17(21%)	16(11%)	9(11%)	7(12%)	65(14%)
Codify	14(13%)	11(13%)	30(20%)	13(17%)	11(18%)	79(17%)
Store	27(26%)	24(30%)	31(21%)	20(26%)	9(15%)	111(24%)
Maintain	13(12%)	8(10%)	20(14%)	10(13%)	7(12%)	58(12%)
Transfer	30(29%)	17(20%)	41(28%)	23(29%)	24(40%)	135(28%)
Create	5(5%)	5(6%)	9(6%)	3(4%)	2(3%)	24(5%)
Total	105(22%)	82(17%)	147(31%)	78(17%)	60(13%)	472



Highest Occurrence of Knowledge Activity



Lowest Occurrence of Knowledge Activity

In Table 9, it is evident that knowledge transfer at 28 percent (134 n=472) represents the highest intensity of all KAs. For all companies apart from HelpRead Ltd., knowledge transfer was the most intense KA with DocMan displaying the greatest intensity of transfer activity at 40 percent (n=60). This may be due to DocMan's constant interaction and exchange with their Swiss headquarters, they are

particularly focused on ensuring that software requirements are well understood by all parties coupled with the need to maintain contact with the software integrator, who is responsible for integrating the components developed in the Irish office into the complete software product. Knowledge transfer is undoubtedly high across all companies this may be attributed to the flat structure of SMEs where few employees operate in flexible working environments (Younger, 1990).

From Table 9, unlike the other companies the highest incidence of activity occurrence for HelpRead Ltd. is in knowledge storage at 30 percent (24 where n=82). HelpRead's focus on storage activity was highlighted in this study; it may be explained by their focus on establishing a quality system to meet ISO regulations.

Table 9 highlights that knowledge creation activity across all cases was low at 5 percent (234 where n=472). This activity may be low intensity as it is a more difficult phenomenon to observe. However, another reason for the low count of knowledge creation activities could be attributed to the nature of SMEs where it is typical for the manager to be the "driving force" behind the organisation (Nunes *et al.*, 2005) and where the founder has the initial idea and continues to have significant hands on involvement in the running of the organisation (Schein, 1993). In other words, knowledge creation may be the responsibility of a few people in a SME, namely the founder and senior management. Chan and Chao (2008) contend that knowledge generation in SMEs can be improved if management provide more opportunities to software developers in terms of providing opinions and ideas based on their expertise.

7. Knowledge Approach in five SMEs

From this study TravelSoft Ltd. and HelpRead Ltd. can be characterised as knowledge intensive organisations (Davenport and Prusak, 1998; Nonaka, 1995; O'Dell and Grayson, 1998). The considerable number of KAs identified at TravelSoft were the direct result of new product development and process formulation related activity while HelpRead's customer oriented strategy resulted in significant KA. Both TravelSoft and HelpRead relied heavily on external resources as a means of valuable knowledge acquisition. The emphasis on new product (Groen, 2006) and in the case of TravelSoft new process development characterised the nature of the KM approach for these organisations. Essentially, HelpRead and TravelSoft utilised KAs to support their product development activity (Kraaijenbrink *et al.*, 2006). However, this was done in different ways, depending on the current needs of the company. For example in the case of TravelSoft who did not have a software product but were working towards achieving that goal, the total number of KA was significant. Their focus on software development knowledge, but also on travel industry and process knowledge was substantial and they have implemented collaborative web technology and face-to-face workshops (Daft and Lengel, 1986) to support this goal. In essence, their KM approach achieved their needs in terms of the goals set by the company. The findings at HelpRead supported this, although they were not working through new product development at the time, in which case the total number of KAs might have been higher, their knowledge focus and KAs operated to support new feature and product development activity. It would be expected that instances of such activity and the intensity of the knowledge focus on customer driven product development would ramp up, if HelpRead were to begin a new product development phase. Supporting the view of Davenport and Prusak (1998, p178) who state that "*knowledge and learning should always serve the broader aims of the organisation*", depending on their activities and goals HelpRead leverage KM to fit their needs.

Systems Solutions had no formalised approach to managing knowledge; however as a high-technology software consulting organisation KAs occurred organically, although some activity was driven by industry regulation. It was evident that apart from software development and project knowledge, Systems Solutions did not focus on niche industry knowledge. In addition, the company relied on readily available company technology such as desktop applications and shared folders to support all KAs. In the same way, FinSoft Ltd did not have a formalised approach or sophisticated information systems in place to support KAs. However, they too were driven by industry regulation to maintain accurate and up to date documentation. While Systems Solutions and FinSoft leveraged knowledge for reasons different to those of HelpRead and TravelSoft, they too pursued KAs that met the needs of the organisation. For both of these organisations, compliance was a key driver of KA. In addition, senior management sales strategy in both companies created a focus on customer and sales knowledge and supporting activities. With the external compliance pressures and an emphasis on generating sales opportunities, KAs were used to support the needs of these organisations.

As a small satellite office to Swiss headquarters, DocMan's (Ireland) KAs were largely determined by head office. As a result, the nature of their work was highly bound to software component development, while the volume of KA in general was quite low, significant knowledge transfer occurs between the Irish and Swiss office. The company's extensive reliance on knowledge transfer activities reflected the nature of their business objectives, where a KM approach that serves the goals of the Irish based subsidiary is pursued.

The justification for each company's KA is closely matched to the organisational objectives of that firm. Across the cases there was a common focus on software development, project and product knowledge, although niche knowledge was important in some cases. While the number of KAs varied, the case data showed that across the board, these companies were good at knowledge transfer and evidently, weak at knowledge creation, this is supported by extant Irish research (CSO, 2007).

8. Conclusion

Based on considerable extant research a working definition for knowledge and a classification of KAs was established in order to enable the identification of occurrences of KA across the five cases thus providing an account of how knowledge is managed in each organisation. This classification of KAs provides a common vocabulary which is a useful and practical method of assessing the KM approach of software SMEs in both a tangible and practical manner. This classification could be used by software and other types of SMEs to understand and develop their KAs in order to best serve the needs of the firm. While it has been established that SMEs and MNEs differ (Nissila *et al.*, 2004; Penrose 1959; Wong, 2005), using the vocabulary established in this study, larger organisations could leverage the classification to develop their own approach to KM to serve the function's or organisation's activities and goals at a particular time.

This study identifies that KM is adapted based on organisational context e.g. to serve the organisation's business needs as required. In order to leverage KM, an organisation's KM strategy should support the organisation's business strategy and objectives. While the importance of exploiting KM to suit an organisation's strategy is evident from the five cases conducted for this study, additional research should endeavour to understand the rationale for pursuing certain knowledge approaches based on the organisation's goals or objectives (Carlsson, 2001; Duffy, 1999; Davenport and Prusak, 1998), at a particular time or as a result of environmental change. This study shows that, while the organisational objectives and priorities may be different, KM should be implemented to meet the organisations strategy, in essence developing the appropriate KAs to fit the knowledge needs of the firm, for example, to support new product development activity or to support a focused sales strategy when required. However, if organisational objectives change as a result of environmental uncertainty it would be anticipated that the organisation should realign their KM approach to support new objectives and activities. In effect, an ideal situation requires that an organisation is flexible enough to leverage alternate KAs depending on the businesses needs at a specific time. Essentially, SMEs consider the economy of knowledge when they expend resources to manipulate knowledge in a way that is commensurate to the benefits that stand to be obtained from this effort. This principle has clear implications for further research and practice, as the benefits obtained from a firm's KM approach must be in keeping with the efforts of its implementation and daily use.

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